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ABSTRACT

A group of 105 lower-lower middle class kindergarten children were tested on a set of single variable classification tasks and related-component tasks dealing with color and number. Children who failed to reach criterion on the classification test were randomly assigned to one of five experimental groups, stratified on the basis of performance on both the classification and Component Test scores. Each group was given instruction on classification tasks, component tasks and/or control tasks, followed by Classification and Component Posttests. Children receiving classification instruction performed significantly better on the Classification Posttest than control groups who did not. Children who received component instruction performed better than the comparison group that did not receive it, although the difference was statistically significant only for one of three levels of pretest performance. There were no apparent effects of classification instruction on Component Posttest performance or of component instruction on Classification Posttest performance. (Author)

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KINDERGARTEN TRYOUT OF SINGLE VARIABLE CLASSIFICATION TASK PROTOCOLS

Edward L. Smith

ABSTRACT

A group of 105 lower-lower middle class kindergarten children were tested on a set of single variable classification tasks and related-component tasks dealing with color and number. Children who failed to reach criterion on the classification test were randomly assigned to one of five experimental groups, stratified on the basis of performance on both the Classification and Component Test scores. Each group was given instruction on classification tasks, component tasks and/or control tasks, followed by Classification and Component Posttests.

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KINDERGARTEN TRYOUT OF SINGLE VARIABLE CLASSIFICATION TASK PROTOCOLS

Single variable classification involves subsets, each of which contain all the elements of a set characterized by a single value of the classification variable. In this tryout, kindergarten children's skill in classifying pictures of objects on the basis of readily observable variables (color and number) was investigated.

A recently developed approach to the design of instruction is hierarchical analysis as proposed by Gagné (1968). This approach involves selecting an important criterion behavior or task and preparing and evaluating tenative answers to the question, "What must an individual be able to do to readily learn the criterion behavior?" The central theme of the approach is the achievement of positive transfer from the learning of tasks at one level of the hierarchy to the learning of tasks at the next level. This tryout is part of an application of this approach to the design of experimental protocols or instructional sequences for teaching single variable classification tasks.

Purpose of the Tryout

Two experimental protocols were prepared for use in teaching the classification tasks to kindergarten children who had not previously mastered them. The Classification Protocol provided children with instruction and practice on the classification tasks themselves. The Component Protocol provided children with instruction and practice on a set of component tasks, the prior learning of which was hypothesized to facilitate learning of the classification tasks.

The purpose of the tryout was to:

1) determine the readiness of kindergarten children to learn the classification tasks, and
2) determine the effects of instruction for the component tasks on subsequent learning of the classification tasks.

The answers to these questions reflect on the value of and the need for the hierarchical analysis which resulted in the hypothesized component tasks.

Tasks

The classification and component tasks involved in the tryout (see Table 1) were selected on the basis of a hierarchical analysis of description, comparison, and classification skills (TN-2-71-25). That analysis made use of task features made explicit by careful descriptions of the tasks prepared using standard conventions designed for that purpose (TN-2-71-12). These features are reflected in the brief descriptions and codes presented in Table 1. For example, tasks 1, 5, 6, and 8 all involve responding to a variable name (symbolized by "p" on the right side of the task codes).

Content

The practice and test items required the children to perform the tasks using the variables color and number (e.g., number of windows) with line drawings of objects. The pictures used in the protocols were of different objects from those in the tests. The objects in the protocol

TABLE 1

TASKS INVOLVED IN THE TRYOUT

Number	Code	Task
1	dv	Selecting values for given objects.
2	dp	Producing values for given objects given the variable name.
3 4	p/dS1 p/dD1	Identifying the variable on which given objects are the same/different.
5 6	fS2p fD2p	Forming subsets of objects similar/different on a variable given the variable name.
7	p/dC1	Identifying the variable on which given objects are classified.
8	fC2	Forming subsets of objects each of which are the same on a variable given the variable name.
9	fp/dC3	Forming subsets of objects, each of which are the same on a variable and identification of the classification variable employed.

Key: Symbols on the left of the codes represent requirements, those on the right represent givens.

d - description

v - values

p - variable name

S - similarity task

D - difference task

C - classification task

1 - task requires variable identification only

2 - task requires subset formation only

3 - task requires both variable identification and subset formation

items differed only on color and number, while those in the test items differed on color, number, and position (e.g., position of windows). Thus, the tests represent generalization to new objects and to sets of objects differing on one more variable, one on which the children were not instructed. The test items did not require the child to perform the tasks on the new variable, although the children were free to use new variable in the free classification task.

Instrumentation

Tests

Both the Classification Test and the Component Test were individually administered and involved line drawings of insects, plants, and houses differing on color, number, and position.

Classification test

The Classification Test consisted of five items: one for the C3 task, two for the C1 task, and two for the C2 task. The objects were varied among three forms of the test so that each object was used for each task-variable combination, thus balancing across forms for the effects of the objects. The free classification item was presented first to avoid suggestion of a classification variable by the other items. The identification items were presented next to avoid the suggestive influence of variables named by the tester in the C2 items. Each item presented the child with a set of twelve pictures. The test is described in more detail in the Appendix and elswhere (Smith & McClain, 1971).

Component test

Three forms of the Component Test were employed, each consisting of twelve items. The objects pictured were varied so that each object was used for each task-variable combination, thus balancing across forms for the effects of the objects. The identification tasks were presented first to minimize the effects of variables and values named by the tester in the selection and description tasks. The description task items presented the children with single pictures. The comparison tasks presented them with sets of three or five pictures. The constitution of these sets and the test format are described in the Appendix.

Protocols

The protocols provided the children with sample items and simple explanations (instructional cues) for each task, followed by practice on items of increasing complexity with feedback on responses. As stated above, the protocol items presented the children with pictures of objects differing only on color and number.

The Classification Protocol consisted of two parts, each containing four instructional cues and twenty practice items. All three classification tasks were practiced in each part. The Component Protocol also consisted of two parts. Part 1 contained eight instructional cues and thirty-six practice items. Part 2 contained eight cues and twenty-six items. All six component tasks were practiced in each part.

Two control protocols were also employed in the tryout. Control Protocol A required the children to name and identify objects and parts of objects that were employed in the Component Protocol. Control Protocol

B required the same for objects that were employed in the Classification Protocol. The Control Protocols thus control for the effects of individual attention and participation in the study, exposure to the instructional materials, and learning resulting from the pretests.

Subjects

The subjects were drawn from four kindergarten classes at a local elementary school in zone D of the Los Angeles City School System. This area is a lower, lower-middle income area with a substantial Mexican-American population. Approximately one-third of the children in the study had Spanish surnames. The study was conducted in May at which time the mean age of the children was 72.0 months. The children had not received any special instruction on classification prior to the study and had not been involved in any other SWRL tryouts or studies.

Procedures

A group of 105 kindergarten children was pretested on both the classification and component tasks. Seventy-five children failed two or more items on the Classification Pretest. From these children, five groups were formed using a stratified random sampling procedure (see Table 2). Substitutions were made for two children who were found to have severe problems comprehending English. A child who had obtained a score of five on the Classification Pretest was mistakenly placed in Group IV. The data for this child are not included in the analysis, thus accounting for the smaller number of children shown in that group in Table 2.

TABLE 2

FORMATION OF FIVE EXPERIMENTAL GROUPS STRATIFIED ON CLASSIFICATION AND COMPONENT PRETEST SCORES

Group	Number of Children Randomly Assigned to Groups by Levels									
	Low Class. (Score=0 to 1)			Med. Class. (Score=2)			Hi Class. (Score=3)			
	Low Comp. (Score= 0 to 6, N=5[1])	Med. Comp. (Score 7 to 8, N=12[1])	Hi Comp. (Score= 9 to 12, N=5[1])	Low Comp. (Score= 0 to 6, N=7[1])	Med. Comp. (Score= 7 to 8, N=5[1])	Hi. Comp. (Score= 9 to 12, N=7[1])	Low Comp. (Score= 0 to 6, N=8[1])	Med. Comp. (Score= 7 to 8, N=13[1])	Hi Comp. (Score= 9 to 12, N=9[1])	Total
I	1	2	1	1	1	1	1	2	2	12
II	1	2	1	1	1	1	1	2	2	12
III	1	2	1	1	1	1	1	2	2	12
IV	1	2	1	1	1	1	1	2	1[2]	11
V	1	2	1	1	1	1	1	2	2	12
Total	5	10	5	5	5	5	5	10	10	60

[1]Indicates the number of children that were available to assign to groups for that cell.

[2]A child with a score of 5 on the Classification Test was mistakenly placed in this group and assigned to Group IV. This child was subsequently dropped from the anaiysis.

The experimental groups all received individually administered instruction according to the design shown in Table 3. Each protocol was individually administered in two parts, each part on a separate day. Thus, the children in Groups I, II, and III had four instructional sessions over a period of about one week while Groups IV and V had two. Following completion of the instruction, the children in all groups were given the Classification Test and, on a subsequent day, the Component Test.

The data, in the form of Classification and Component Test scores, were analyzed with an analysis of variance procedure appropriate for designs with unequal frequencies (Winer, 1962), and a corresponding procedure for determining the significance of differences between specific groups (Winer, 1962). Scores on the Classification and Component Pretests were used as blocking variables in three-way designs with the Classification Posttest scores and Component Posttest score as dependent variables.

Results

The group means and standard deviations for the two posttests are presented in Table 4. For the Classification Posttest, significant main effects were obtained for the experimental groups factor ($p < .01$) and the classification pretest factor ($p < .05$). The interaction between these factors was also significant ($p < .01$). These effects are illustrated in Figure 1. There was also a marginally significant interaction between the two pretest factors. For the Component Posttest, significant main effects were obtained for the experimental group factor

TABLE 3

EXPERIMENTAL DESIGN

	Group				
	I	II	III	IV	V
Pretest	Criterion Test Component Test	Criterion Test Component Test	Criterion Test Component Test	Criterion Test Component Test	Criterion Test Component Test
Experimental Treatment	Component Protocol	Control Protocol A	Control Protocol A		
	Classification Protocol	Classification Protocol	Control Protocol B	Classification Protocol	Control Protocol B
Posttest	Criterion Test Component Test	Criterion Test Component Test	Criterion Test Component Test	Criterion Test Component Test	Criterion Test Component Test

TABLE 4

EXPERIMENTAL GROUPS' CLASSIFICATION AND COMPONENT POSTTEST MEANS AND STANDARD DEVIATIONS

Group	Classification		Component	
	$\bar{X}$	SD	$\bar{X}$	SD
1	4.25	.60	10.42	1.11
2	4.33	1.11	8.83	1.91
3	2.75	1.09	8.67	1.70
4	3.73	1.14	7.73	1.71
5	2.42	1.50	8.25	2.24

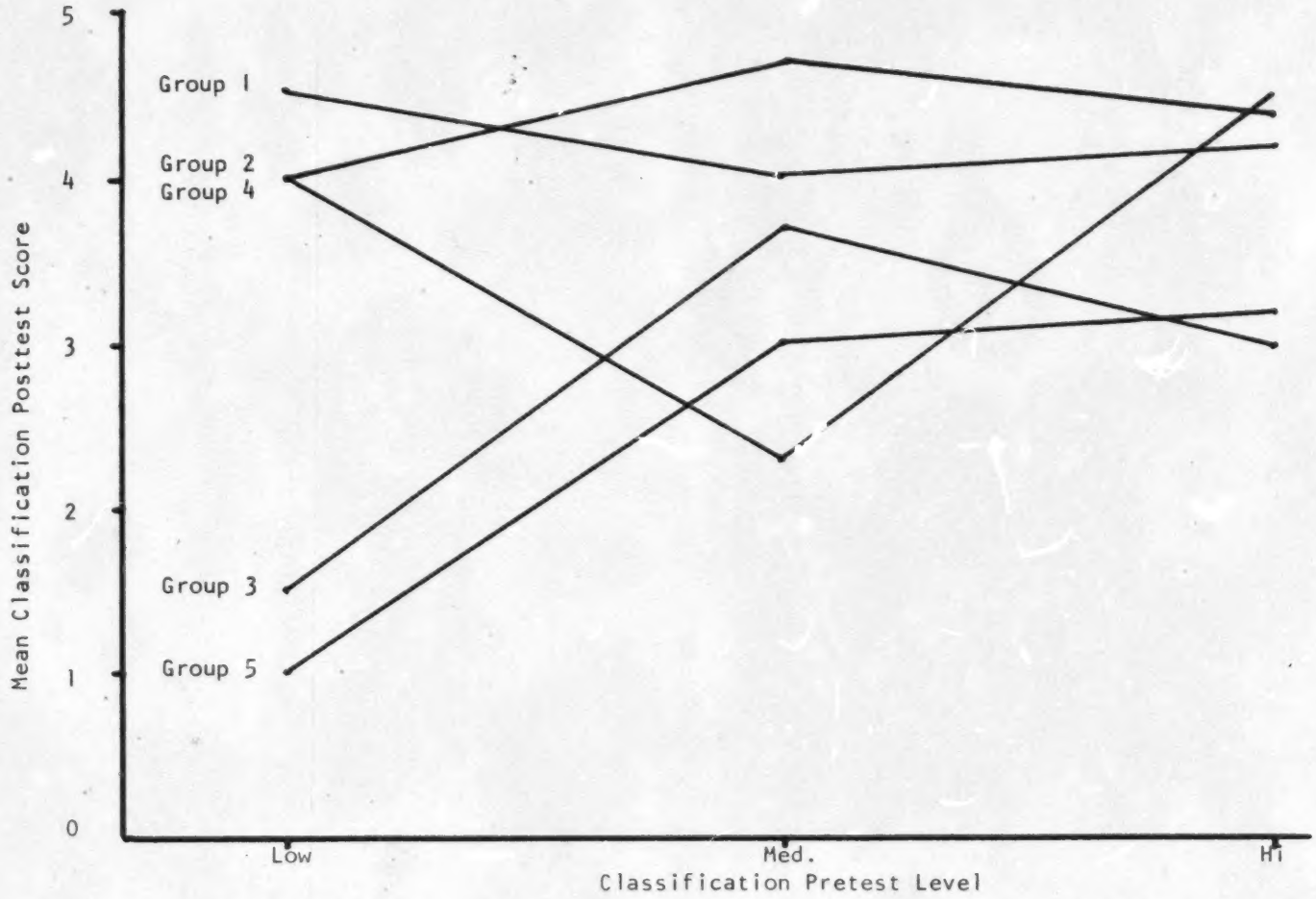

Figure 1. Mean Classification Posttest Scores for Experimental Groups by Pretest Levels.

($p < .05$) and the component pretest factor ($p < .01$). These effects are illustrated in Figure 2. No significant interactions were obtained. The results will be presented in the form of answers to specific questions regarding the effects of the experimental protocols on posttest performance.

1) Does the Classification Protocol produce significant improvement in kindergarten children's performance on the Classification Test?

The relevant comparisons (Groups II and III, and Groups IV and V in Table 5) indicate that statistically significant improvement was indeed produced. The question of practical significance is more difficult to answer, but as indicated in Table 6, the children receiving the Classification Protocol had a mean increase of 43 percentage points in their test scores as opposed to a mean increase of 11.5 percentage points for the children receiving only the Control Protocols. This increase does seem substantial. Thus, the answer to the first question is yes.

2) Does the Component Protocol produce significant improvement in kindergarten children's performance on the Component Test?

The relevant comparison (Groups I and II in Table 7) yields ambiguous results concerning the statistical significance of the obtained difference. Group I, which received the Component Protocol, was superior to the comparison group (II) at each level of the pretest factor (see Figure 2). However, the difference was significant ($p < .05$) only at the middle level even though the actual difference was larger at the low level. As indicated in Table 8, the posttest performance

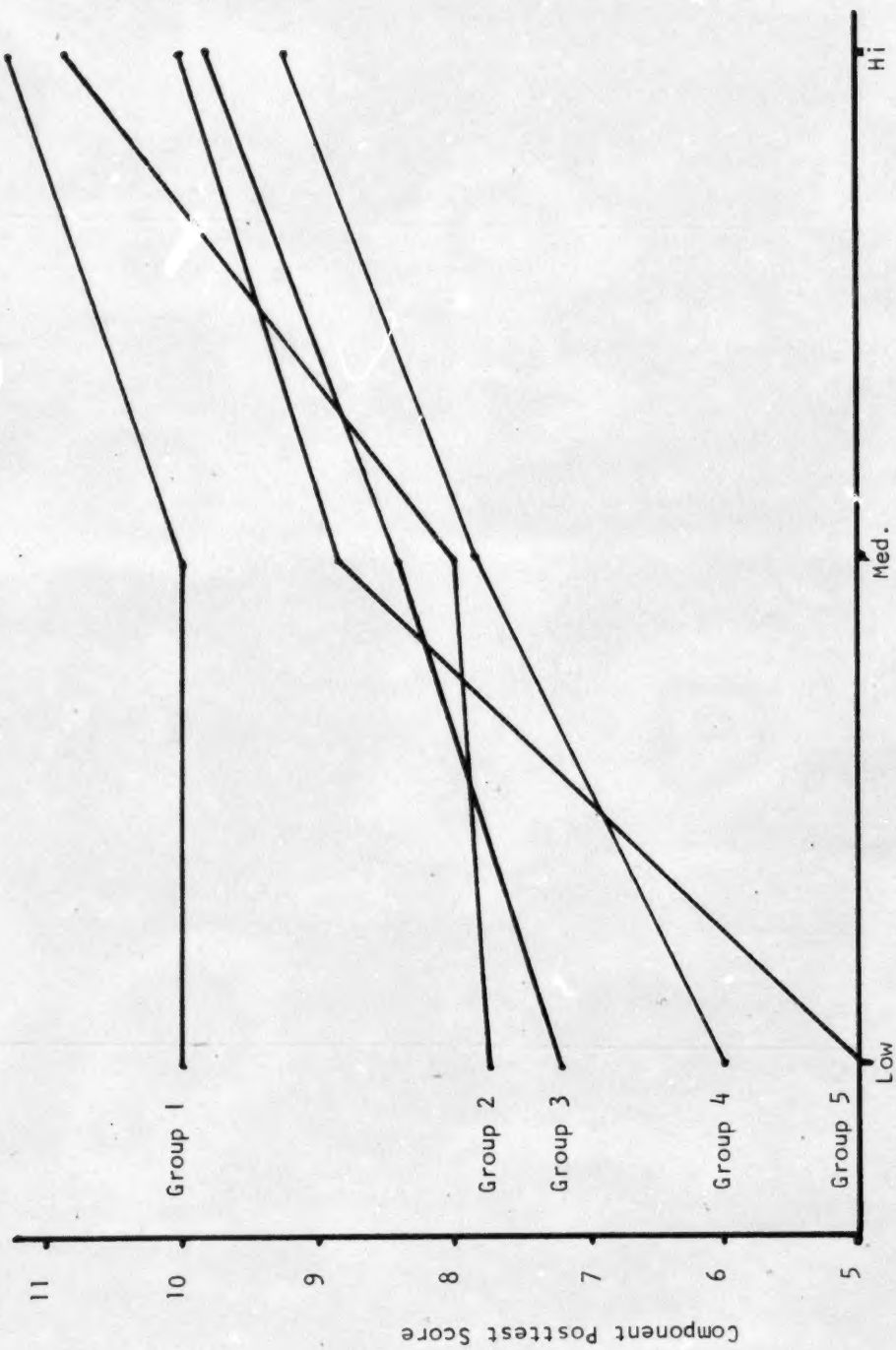

Figure 2. Mean Component Posttest Scores for Experimental Groups by Pretest Levels.

TABLE 5

RESULTS OF COMPARISONS BETWEEN EXPERIMENTAL GROUPS:
CLASSIFICATION POSTTEST

Groups Compared	Instruction to which effect is attributed	Level of Significance[1]			
		Low Pretest	Med. Pretest	Hi Pretest	Total
I and II	Component Protocol	n.s.	n.s.	n.s.	n.s.
II and III	Classification Protocol	.05	n.s.	.05	.05
IV and V	Classification Protocol	.05	n.s.	.05	.05

[1]Employing unweighted cell means procedure for testing for significance of specific differences among means (Winer, 1962).

TABLE 6

MEAN PERCENTAGE SCORES ON THE CLASSIFICATION TEST FOR GROUPS RECEIVING AND NOT RECEIVING CLASSIFICATION INSTRUCTION

Group	N	Mean Percentage Score (% of items correct out of 5)		Difference (Percentage Points)
		Pretest	Posttest	
Instructed				
II	12	40	87	47
IV	11	36	75	39
Mean		38.1	81.3	43.2
Uninstructed				
III	12	42	55	13
V	12	38	48	10
Mean		40	51.5	11.5

TABLE 7

RESULTS OF COMPARISONS BETWEEN EXPERIMENTAL GROUPS:
COMPONENT POSTTEST

Groups Compared	Instruction to which effect is attributed	Level of Significance[1]			
		Low Pretest	Med. Pretest	Hi Pretest	Total
I and II	Component Protocol	n.s.	.05	n.s.	n.s.
II and III	Classification Protocol	n.s.	n.s.	n.s.	n.s.
IV and V	Classification Protocol	n.s.	n.s.	n.s.	n.s.

[1]Employing unweighted cell means procedure for testing for significance of specific differences between means (Winer, 1962).

TABLE 8

MEAN RAW AND PERCENT COMPONENT TEST SCORES
FOR GROUPS I AND II

Group	N	Pretest		Posttest		Gain	
		Raw	Percent	Raw	Percent	Raw	Percent
I							
hi	4	10.25	85	11.25	94	1.00	9
med	5	7.60	63	10.00	83	2.40	20
lo	3	5.00	42	10.00	83	5.00	41
mean		7.83	65	10.42	87	2.39	22
II	12						
hi	4	10.00	83	10.75	90	.75	7
med	5	7.20	60	8.00	67	1.20	7
lo	3	5.70	48	7.30	61	1.60	13
mean		7.75	65	8.83	74	1.08	9

for the low level of Group I represents an increase of 41 percentage points (as opposed to 13 for the low level of Group II), a substantial increase. Tryout of the protocol with a larger number of such children will be required to determine whether this is actually nonrandom effect, although the pattern of gain scores suggests that it is.

The answer to the second question is unclear because of the small number of children in the low level on pretest performance. A tentative yes, however, seems appropriate.

3) Does the Component Protocol facilitate kindergarten children's learning of classification tasks via the Classification protocol?

The relevant comparison (Groups I and II in Table 7) indicates that no significant differences were obtained. Examination of Figure 1 seems to allow no other interpretation than that the Component Protocol had no effect on Classification Posttest scores. This does not prove that there were not positive (or negative) effects on classification skill as a result of the Component Protocol. The possibility of unobserved effects is made plausable by the high performance of most of the children who had the Classification Protocol, producing a ceiling on Classification Posttest scores. However, there is no evidence for any effects in the data reported in this paper. Thus, the answer to the third question seems to be no.

4) Does the Classification Protocol incidentally produce significant improvement in kindergarten children's performance on the Component Test?

Although the Classification Protocol does not offer explicit instruction or practice on the component tasks, it might be expected that skill on those tasks would be enhanced due to their underlying similarity to the classification tasks. Such an effect would help explain why the Component Protocol did not appear to facilitate learning of the classification tasks. The comparison between Component Posttest performance of Groups II and III, and Groups IV and V are relevant to this question. As shown in Table 7, no significant differences were obtained in these comparisons. The information in Figure 2 is also consistant with the interpretation that the Classification Protocol had no effect on Component Posttest performance.

Conclusions

The results described above indicate that most of the kindergarten children were ready to learn the classification tasks without preliminary instruction on component tasks. The tryout was conducted on a rather narrow sample of children. However, the fact that they were not from an advantaged area and that many were minority group members with the added problems associated with nonstandard English usage, suggests that most kindergarten children who have not already mastered those tasks would probably exhibit such readiness. This indicates that hierarchical analysis of the classification tasks involved in this tryout is superfluous for kindergarten children in general. However, such analysis may be of significance for younger children and, for diagnostic purposes, for individual kindergarten children.

The effects of instruction for the component tasks on the learning of the classification tasks are also important in evaluating the approach used in the analysis which produced them. These effects, or their absence, reflect most directly on the task features used to define relations between the component tasks and the classification tasks (Smith, 1971). This tryout indicates that the features employed are not powerful enough to be predictors of positive transfer of learning, at least by themselves. Before these features are dismissed however, the relations between all the tasks should be analyzed using correlational and analysis of variance techniques on the pretest results. If substantial relationships are found where predicted on the basis of the task features, these features might be employed in future analyses in conjunction with other features and/or specific transfer devises such as verbal mediators. The pretest performance on each component task should also be studied to determine the validity of the test questions and whether or not some of the tasks had already been mastered by the children. This analysis would seem warranted in light of the high Classification Posttest performance of all groups receiving the Classification Protocol which probably made the Classification Test a somewhat insensitive devise due to a ceiling effect on posttest scores.

In future studies of this type, analyses of performance of children on tests of both the criterion and component tasks should be carried out before protocols are prepared and tried out. Also, more extensive measures could be used to assess the impact of component tasks instruction. These could, for example, assess retention and a greater degree of generalization than that represented by the test employed in this tryout.

APPENDIX I

TABLE 9

CLASSIFICATION TEST FORMAT

Item	Task	Variable	Objects		
			Form A	Form B	Form C
1	C3	color/number/ position	insects	houses	plants
2	C1	color	houses	plants	insects
3	C1	number	plants	insects	houses
4	C2	color	plants	insects	houses
5	C2	number	houses	plants	insects

TABLE 10

CONSTITUTION OF SETS OF ELEMENTS FOR CLASSIFICATION TEST ITEMS

	Element											
Variable	1	2	3	4	5	6	7	8	9	10	11	12
color	red	red	red	yellow	yellow	yellow	yellow	yellow	blue	blue	blue	blue
number	1	2	3	1	1	2	2	3	1	1	2	3
position	a	b	c	a	b	a	c	b	b	c	b	a

TABLE 11

COMPONENT TEST FORMAT

Item	Task	Variable	Objects		
			Form A	Form B	Form C
1	S1	color	houses	plants	insects
2	S1	number	plants	insects	houses
3	D1	color	houses	plants	insects
4	D1	number	plants	insects	houses
5	S2	number	houses	plants	insects
6	S2	color	plants	insects	houses
7	D2	number	houses	plants	insects
8	D2	color	plants	insects	houses
9	dp	color	houses and plants	plants and insects	insects and houses
10	dp	number	houses and plants	plants and insects	insects and houses
11	dv	number	houses and plants	plants and insects	insects and houses
12	dv	color	houses and plants	plants and insects	insects and houses

TABLE 12

CONSTITUTION OF SETS OF OBJECTS FOR THE COMPARISON TASKS

Task	Variable	Describers[1]				
		Object 1	Object 2	Object 3	Object 4	Object 5
S1	target (color/number)	a_t	a_t	a_t	a_t	a_t
	distractor 1 (position)	a_1	a_1	a_1	b_1	c_1
	distractor 2 (number/color)	a_2	b_2	c_2	c_2	c_2
D1	target (color/number)	a_t	b_t	c_t		
	distractor 1 (position	a_1	a_1	b_1		
	distractor 2 (number/color)	a_2	b_2	a_2		
S2	target (color/number)	a_t	a_t	a_t	b_t	c_t
	distractor 1 (position)	a_1	b_1	c_1	a_1	a_1
	distractor 2 (number/color)	a_2	b_2	c_2	c_2	c_2
D2	target (color/number)	a_t	b_t	c_t	a_t	c_t
	distractor 1 (position)	a_1	b_1	c_1	a_1	b_1
	distractor 2 (number/color)	a_2	b_2	c_2	b_2	c_2

[1]A value for the appropriate variable was assigned to each letter to generate a description. For the S1 color item, for example, a_t = yellow on each form of the test.

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